ROLE OF DYNAMIC GEOMETRY SOFTWARE IN EDUCATION AND DEVELOPMENT OF SOLVING SKILLS OF GEOMETRIC PROBLEMS BASED ON VAN HIELE MODEL

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***ABSTRACT**: Nowadays, geometry teaching is very important because it has been considered as a tool for understanding, description and interaction with place of life. Purpose of present research is to study role of dynamic geometry software in education and development of solving skills of geometric problems based on Van Hiele model. The research was semi-experimental and pre-test and post-test method by statistical society of 260 girl students of second class at high schools of ward 19 of Tehran education department in school year 2013-14. 58 samples (29 persons as test group, 29 persons as control group) were selected statistical by simple random sampling. A researcher made test based on Van Hiele model was used doe evaluating studying variables. Findings of the research based on student t test and covariance analysis showed that teaching by method of dynamic geometry based on Van Hiele model has more positive effect on problem solving skills of students than traditional method.*

Keywords: dynamic geometry, GeoGebra, problem solving skill, Van Hiele model

INTRODUCTION

Some experts consider the process of teaching and learning apart, but most learning researchers and psychologists believe that as the sale is not possible without the purchase, teaching without learning is not possible [1]. Consequently, teaching is should be known as an activity with the aim of creating and facilitating learning in learners.

Traditional teaching is teacher-centered and hegemonic. Teachers use the dictated teaching methods so that they make the students full of information.Students are expected to maintain their information andrecall them in their exams. At the end of the academic year, theachievement of students in gradesin their exams is confirmed.Scores and ratings are the mostteaching efficiency at schools. This type of teachingbased on the "accumulation of information" puts a lot of stress on students and becomes pointless and boring.Also, most of the knowledge that students acquire at school is alien to the ways of individualthinking, so that they fail while using that knowledge to solve every day problems [2].

Geometry problem solving is often challenging for students. Weakness of memory, the mobilization of previous knowledge, choosing the right strategy and the transition from theory to achieve the proof (inductive reasoning towards deductive reasoning) are the major problems of the students. The lesson which has the inner aspect of research is interesting for students [3].

Council of Teachers of America [4] consider the problem solving as an activity for which there is not already any solution. For this reason, to find a solution, students should draw it from their inner knowledge and thus they will develop an understanding of mathematical concepts through this process. Solving problems is not just a goal of learning mathematics but is an essential and comprehensive tool and method of doing mathematics. Students should have abundant and frequent opportunities for formulating, tackling and solving the complicated problems that require efforts and then they should be encouragedto have reflection on their thoughts and reactions.

Today, new studies have been conducted on teaching geometry using computer technology and multimedia which are focused around the effects of dynamic graphics. The method of teaching geometry using the moving images that have the manipulation capabilities is called dynamic geometry. Dynamic graphics as a mediator to learn have attractedthe attention of many people in the field of mathematics education [5] Using dynamic graphics in multimedia learning environments provides opportunities to explore the concepts of geometry [6].

The purpose of present research is to study role of dynamic geometry software in education and development of solving skills of geometric problems based on Van Hiele model. The research variables include: problem-solving skills as the dependent variableand dynamic training method based on Van Hiele model was considered as the independent variable.

This study seeks to answer this question:

Does the dynamic geometry software (GeoGebra) affect the education and development of problem solving skills based on Van Hiele model?

One important reason for teaching geometry at school is its high capacity and ability to teach “problem solving”. When learners are faced with a situation in which they cannot answer quickly using the information and skills that are available at that moment or when they have a goal but did not find a way to achieve it, they are faced with a problem situation. According to the definition of the problem it can be said that problem solving is identifying and applying the knowledge and skills that lead to the correct answer of the learner to the situation or hisdesired goal [7]. Teaching method and textbooks are two fundamental factors in teaching geometry and increasing the problem-solving ability of students. Throughout the history of education, problem solving has been one of the important goals of education and one of the demands of parents and teachers has been gaining the ability of problem solving by students [7].

During the process of problem solving in mathematics, students can acquire the ways of thinking and thinking and institutionalizethe habits of persistence, perseverance, and curiosity in orderto make confidence in the face of unknown situations, so that these skills will help students to be good at the real world namely the world outside the mathematics world. Problem solvers can achieve great distinctions and privileges in everyday life and the workplace. Problem solving is like a process to reach a solution [8-10].

One reason for the absence of teaching problem solving is that since several years ago the mathematics educators believed that problem solving cannot be taughtbut is an art or ability that some people have and some do not. A teacher who teaches geometry in today's world should not only be aware of the learning ways of students but also should take advantage of technology which improves the students learning because technology provides the possibility and need of reviewing mathematics that students should learn and how to learn it better [4].

Two German teachers named Pierre Van Hiele and Vienna Gold of Van Hiele in 1950 were the first ones who focused on the students' learning difficulties in geometric concepts. They explain that why students have difficulties in learning geometry in general in writing and in particular in proving. Levels of geometric thinking is a description of the ways of thinking found in thelearning geometry by students. In these levels, it is not stated how much knowledge a person has but they describe how a person thinks about the geometric ideas. In fact, Van Hiele approach puts an emphasis on the psychology of mental development and language development (not physical) in the teaching of geometry. It means that teaching the issues of geometry should be commensurate with the level of mental-languagedevelopment in students. If teaching is far beyond the intellectual development of students it will cause the failure and hatred of students and on the other hand if teaching is lower than the level of geometric thinking it will be boringfor the student. Van Hiele believes that the transition from one level of geometric thinking to the next level is not a natural process but it occurs under the influence of teacher training programs [11]. Unfortunately, some of the training programs push the students towards retaining the concepts not understanding them. This is where a large part of the goal of teaching geometry which is "the development of ability and reasoning" is failed. To develop the logical skills of students, it is necessary to design some informal activities in this area using the verbal ideas and images [2].

GeoGebra software as a Van Hiele model tool makes it possible to visually teach geometry in the classroomand makes adynamic and constructive interaction between the teacher, student and computer to provide an environment which allows the student to explore and design the geometric problems from basic concepts to complicated problems and also discover the relationship between geometry, properties and features. As a result, students and teachers (as a facilitator of learning) will be able to make the shapes for research and building infinite geometric shapesand manipulate them to achieve the ideal and problem solving. While the students of a traditional classroom cannot get enough of problem-solving skills [12]. Morgan [13] raises four questions to determine and evaluate the necessary changes to the suitable curriculum with the use of dynamic geometry software:

1. How can technology help students to learn the intermittent or sporadic concepts?
2. How can technology actively engage students in the learning process?
3. How can technology specify the interaction with students higher than the Bloom's taxonomy?
4. How can technology increase the productivity of students?

These questions as the communication bridge of coordinate, the definition of defined algebraic functions and the dynamic geometry software (DGs) include concepts such as points, segments, and lines and conic sections. One of the basic features of GeoGebrais the integration of the two systems CAs and DGs [14] Over the past decade, there has been a big change in the software package. Among the large number of dynamic geometry software, thetwo powerful and effective programsin teaching mathematics have a high influence: DGs andCAs. Thetwo programshave a tremendous impact on learning mathematics but there was no relationship between them. Fortunately, GeoGebra could combine the two programs to teach mathematics effectively [15-17].

The various frameworks of technology and their evaluation are tools developed forevaluating the quality and effectiveness of educational technology applications [18]. However, these framework and toolswere not investigatedfor decision making by teachers in the context of geometry and measurement. Teachers evaluate several factors in order to choose the use of technology for teaching geometry. GeoGebra as a main framework for structural planning emphasizes the integration and application of knowledge. Learning geometry due to the Van Hiele levels in GeoGebra software environment develops as follows:

Level one (diagnosis): When the students see pictures during the show they diagnose them by comparison and initial recognition and decide to build understanding not to bring reasons.

Level two (analysis): When the students see pictures as a set of attributes they diagnose and name them, but do not see the relationship between these characteristics. Students may describe a topic to list all the features, but do not make a relationship between them.

Level three (informal reasoning): When the students do understand the relationships between these features and images, they create meaningful definitions and raise discussions to prove their reasons. For example, understanding that a square is a kind of rectangle, here the formal role and concept of induction are not understood.

Level four (formal reasoning): When the students can construct the proof, understanding the principles and definitions of relevant terms is necessary. At this level, the students should be able to construct a proof as a geometry classroom activity.

Level five (accuracy): When the students understand the induction samples and use them for organizing the mathematical tools. At this level, the students understand the non-Euclidean toolsusing indirect proofs and proof by reductio ad absurdum [19].

MATERIALS AND METHODS

Research project: The present study is applied and pseudo-experimental with the aim of examining the role of dynamic geometry software in education and development of solving skills of geometric problems based on Van Hiele model. To do this, a part of the book Geometry 1 of the high school second gradewas taught based on the theory of Van Hiele and using the dynamic geometry (GeoGebra).

Population, sample and sampling method: The statistical population in this study consists of 260 female students in the second grade of highs school at District 19 of Tehran education system in 2013-2014. According to the Cochran formula, the sample size was determined as58 subjects and using simple random sampling, two classes of 29 members were selected as case group and control group.

Research tool: The research instrument in this study is a twenty multiple choice test designed by the researcher that is based on the geometric thinking levels and geometric skills. The levels of geometric thinking based on Van Hiele model are diagnosis(visual), analysis (descriptive) and inductive (theoretical) and geometric skills mean the drawing, logical and practical skills.

Test reliability: To calculate the reliability of the test, a test was performed among 15 students of the case group and control group before the final implementation of the test and their Cronbach's alpha coefficients were calculated. 0/899 was obtained for pre-test and 0/932 was obtained for post-test and statisticallywhen the Cronbach's alpha is more than 0/60 it has reliability and indicates that the designed testhas a high reliability.

Test validity: To determine the validity of tests, the opinions of 30 mathematics teachers at District 19 of Tehran education system who had the experience of teaching Geometry 1, and 15 top teachers of geometry were used in a team meeting held at the Education Ministry in Tehran and then the tests wereapproved.A pre-test was performed on both groups to indicate that there is no significant difference between two groups from the beginning. Then, the independent variable in this research which is the geometry teaching with the use of GeoGebra software based on the theory of Van Hiele was used only in the case group. Finally, the post-test was performed on both groups.

Data analysis: For data analysis, using t-student test and analysis of covariance based on the scores of students (the two groups of control and case) in the researcher-made pre-test and post-test, the scores of students were analyzed in groups of control and case.

RESULTS

Using t-student test and analysis of covariance based on the scores of students (the two groups of control and case) in the researcher-made pre-test and post-test, the scores of students in the first and second semesters were analyzed in groups of control and case that are shown in the following tables.

Table 1. Mean and standard deviation of the difference between the scores of pre and post-test in the control group

Evaluation	Differences between the scores of pre and post-test in the control group	Mean	Standard deviation	P-Value
skill	Pre visual and post visual	-5/34	5/96	<0/001
	Pre descriptive and post descriptive	-13/27	9/18	<0/001
	Pre theoretical and post theoretical	-4/14	6/95	0/003
Thinking level	Pre drawing and post drawing	-12/06	5/75	<0/001
	Pre logical and post logical	-10/52	8/69	<0/001
	Pre functional and post functional	-5/34	7/18	<0/001

Table 2. Mean and standard deviation of the difference between the scores of pre and post-test in the case group

Evaluation	Differences between the scores of pre and post-test in the control group	Mean	Standard deviation	P-Value
skill	Pre visual and post visual	-8/96	6/59	<0/001
	Pre descriptive and post descriptive	-15/52	6/72	<0/001
	Pre theoretical and post theoretical	-4/31	8/42	0/01
Thinking level	Pre drawing and post drawing	-4/83	7/13	0/001
	Pre logical and post logical	-12/06	8/29	<0/001
	Pre functional and post functional	-9/14	6/69	<0/001

Table 3. Comparing the scores of students in the two groups of control and case, pre-test

Variable		Mean	Standard deviation	FLeven statistics	P-Value Leven	T statistics	Degrees of freedom	P-Value
Visual	control	15/52	5/56	0/42	0/52	-4/73	56	<0/001
	case	22/93	6/34					
Descriptive	control	14/14	5/36	0/68	0/41	-1/3	56	0/19
	case	16/03	5/73					
Theoretical	control	11/03	4/09	3/43	0/07	-2/54	56	0/014
	case	14/31	5/62					
Drawing	control	12/58	4/93	0/77	0/38	-6/63	56	<0/001
	case	21/89	5/73					
Logical	control	15/69	5/13	2/03	0/16	0/12	56	0/91
	case	15/52	6/17					
Functional	control	13/1	4/31	3/67	0/06	-2/92	56	0/005
	case	17/07	5/9					

Table 4. Comparing the scores of students in the two groups of control and case, post-test

variable		mean	Standard deviation	F-Leven statistics	P-Value Leven	T statistics	Degrees of freedom	P-Value
descriptive	control	27/41	6/76	13/31	0/001	-2/87	44/1	0/006
	case	31/55	3/8					
logical	control	26/21	8/3	5/99	0/018	-0/73	49/89	0/47
	case	27/58	5/76					

It was observed that the scores of all skillsin the post-test were more the pre-testscores. It should be noted that the basis for the evaluation of logical thinking is 35 scores and the evaluation of functional thinking is 30 scores.

As can be seen, the scores of all skills in the post-test were more the pre-test scores. In order to compare the scores of skills and thinking levels of students in both groups of control and case, pre-test, the following results were obtained using the t test for two independent samples.

Independent sample t-test results showed that the average analytical and logical skills are not significantly different for both groups of control and case while other skills had the significant difference. It is noteworthy that despite the lack of significant differences between the descriptive skills of control and case groups, the score of case group was higher than the control group. But the difference between the logical skills of the control group was higher than the case group. The scores of other skills for the case group were more control group.

In order to compare the scores of skills and thinking levels of students in both groups of control and case, post-test, the following results were obtained using the t test for two independent samples.

Independent sample t-test results showed that the descriptive skills are significantly different for both groups of control and case, so that the average score of the case group was than the control group. On the other hand, the logical thinking score between the two groups was not significant at the 5% error level.

DISCUSSION AND CONCLUSION

The results of inferential statistics in relation to the research question: Does the dynamic geometry software (GeoGebra) affect the education and development of problem solving skills based on Van Hiele model? Are as follows:

The scores of students in the case and control groups' had significant difference at the 5% error level. It was also observed that the case group had better problem solving skills than the control group that was traditionally taught. GeoGebra software affects the learning and individual knowledge, highlights thelinks, shows the connections, establishes new relationships between different objects in one's knowledge of network resources, and enhances the understanding of the issue of data and knowledge in order to enrich the perceptions and experiencesof the problem.It also provides different modes of a problem to inform the students that they should think more beforeproviding a final answer and present a more suitableanswer with more precise judgment and focus on his/her performance. Afterthe implementation of their assumptions, it gives more opportunity and facilitates the process of hypotheses and finally shows the appropriate point for solving the problem and controlling the process. Accordinglythe use of this softwareenhances the students' problem-solving skills in geometry. These findings are consistent with the principle of technology in a statement NCTM in 2000 andfocus on its implementation.

Due to the effect of the geometry teaching through GeoGebraon problem solving skills, it can be suggested that the textbooks should be a directed and effectiveactivity in the classroom. While teaching, a context should be provided through lecture and explaining other geometric methods to put the students in problem-solving situations and teachersas guidesshouldfostertheir subjective perceptions and interpretationsin problem solving. Also, the teacher should use aperson named teacher – student to teach learning so that the students could practice in a group session instead of a correction system. Through using GeoGebra, the students can see abstract concepts, communicate with each other and teachers and discover geometry. The ability to electronically detect and determine solutions enhances the students' interest and motivation to geometry and develops the ability of students to solve geometric problems.

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